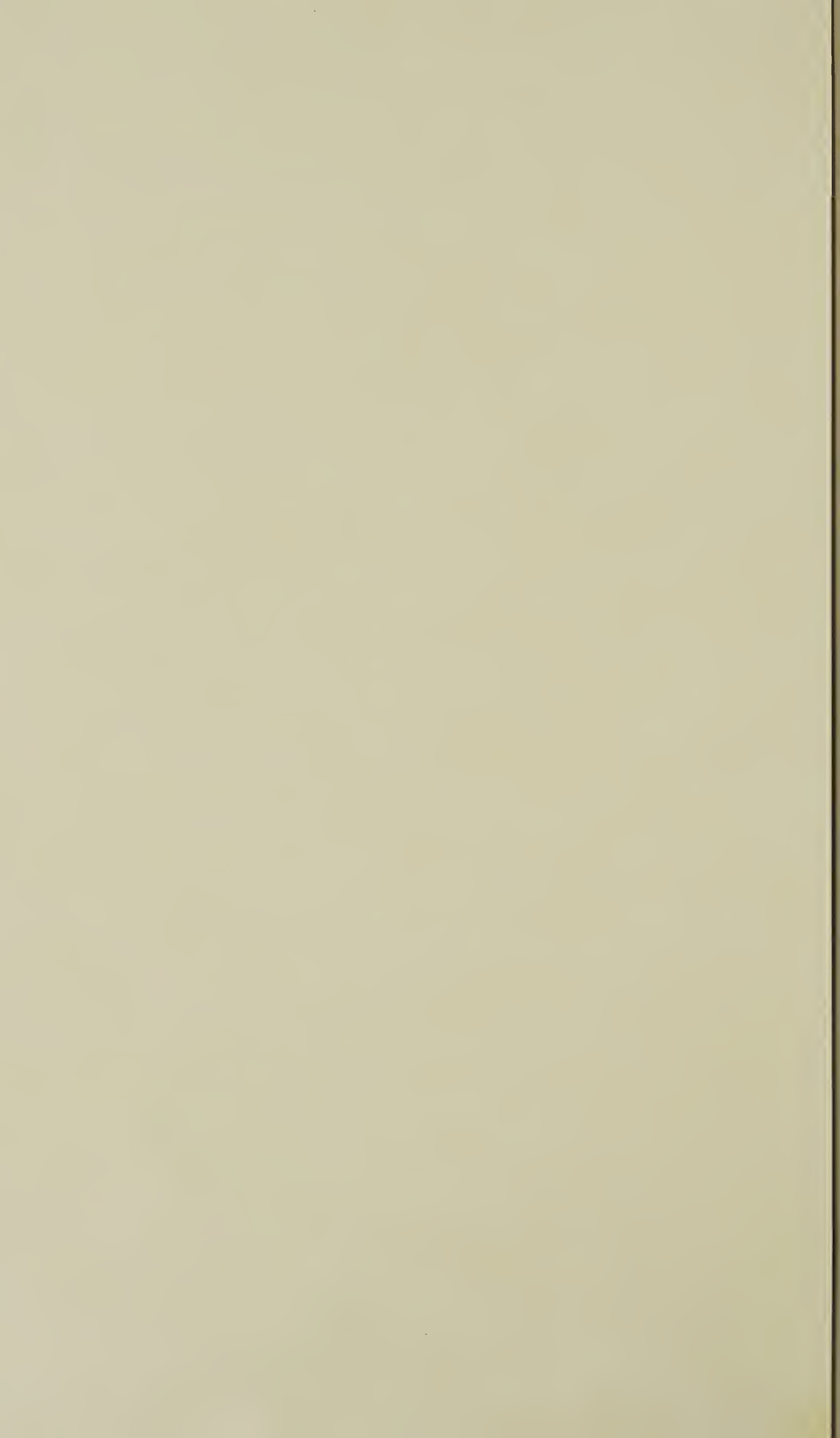


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By Campbell, Robert Samuel

CLIMATIC FLUCTUATIONS

FROM

THE WESTERN RANGE—A GREAT BUT NEGLECTED NATURAL RESOURCE

FOREST SERVICE

U. S. DEPARTMENT OF AGRICULTURE



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CLIMATIC FLUCTUATIONS

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The hardships of the great 1934 drought were too severe to leave any doubt that extreme climatic fluctuations contribute greatly to range depletion. Forage production on ranges was so scant in 1934 that wholesale removal of livestock was necessary in parts or all of nearly every Western State. Where the drought prevailed, range vegetation simply failed to produce sufficient feed to support the numbers of livestock being grazed. Tall grasses in Nebraska (179), grama grasses in Montana and New Mexico, and bunchgrasses in California, in the drought areas, either failed to grow or dried up early in the season.

The 1934 drought emphasized the dependence of range vegetation and its forage production upon climate, especially rainfall. It also forcibly demonstrated the natural fluctuating balance between climate and vegetation, in which range plants increase in abundance and productivity during favorable years, and decline and lose vigor in dry years. Both wet and dry years, singly or in groups, have been occurring ever since man has observed the weather, and vegetation responds to them—a factor beyond man's control. But more than anything else the 1934 drought emphasized the failure of range livestock owners to recognize the extreme fluctuations of forage with the climate, and to manage their ranges in such a manner as to meet these vicissitudes. The worst depletion that occurred in 1934, and during nearly every previous drought, was on overgrazed ranges. So many livestock grazed the scant forage during and after the drought that little or no vigor remained in the vegetation to start a process of restoration that may require decades, especially where wind and water erosion have since removed the unprotected fertile topsoil. This is in marked contrast to the recovery of forage on conservatively grazed ranges.

What happened in 1934 has happened before, and the cumulative effect is no less than widespread depletion of the range resource already outlined—devastating in its immediate effects and far-reaching in its consequences. Each time, climate has played an integral part in the depletion. It is obvious that a sound program of management to restore and maintain the range must include an evaluation of (1) climate and its fluctuations and (2) the influence of such fluctuations upon range vegetation and use.

CLIMATIC FLUCTUATIONS ON WESTERN RANGES

The generally sparse vegetation on western ranges really is remarkably abundant when one considers that the West receives roughly about one-third as much rainfall as the eastern half of the United States (fig. 43). A line drawn through Amarillo, Tex., and North Platte, Nebr., both of which receive about 20 inches of rain-

fall annually, would separate the country into two broad precipitation zones (fig. 44). East of the line, the precipitation is over 20 inches and varies from about 35 inches in the Corn Belt from Iowa to Ohio to about 50 inches in the Cotton Belt of the South (81). West of the line, the rainfall is less than 20 inches except in the mountains. Over most of the range area between Kansas and California it is under 15 inches. The great semidesert region extending from southwestern Arizona to southeastern Oregon receives less than 10 inches. Precipitation in the Rocky and Sierra Nevada Mountains averages more than 20 inches, and more than 60 inches in the Cascade Range of Oregon and Washington.

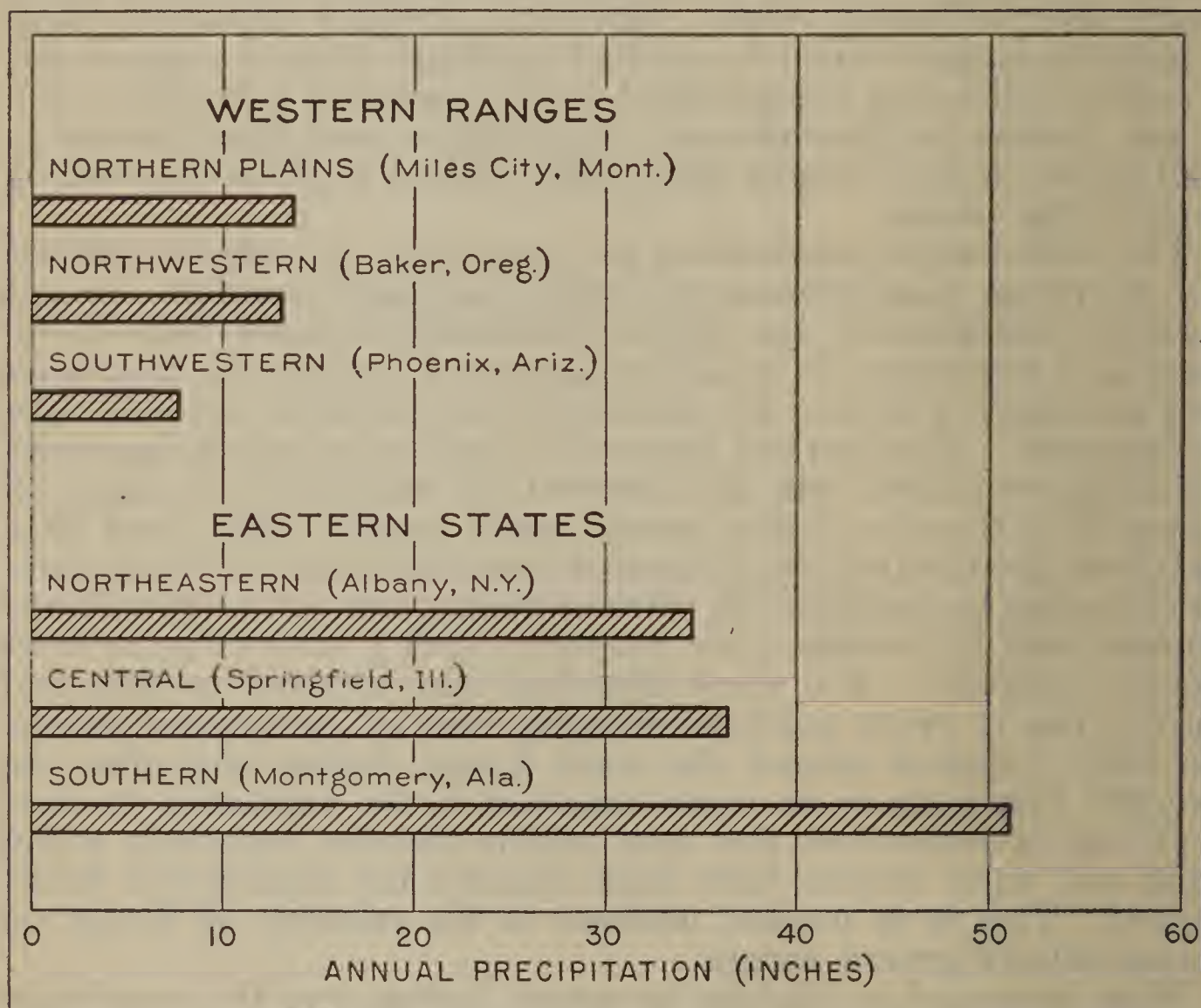


FIGURE 43.—Western ranges are characterized by low average rainfall, as shown by this comparison of precipitation of typical western stations with those in the East.

Temperatures over western ranges as a whole are no higher than in the East (82). However, the combination of low precipitation, high day temperatures, low relative humidity, high evaporation, high winds, and high proportion of sunshine on the western plains and semidesert lands cause plants to use the available water more quickly.

Also, the higher temperatures in the southern half of the range country make conditions for plant growth much more difficult there than in the northern portions of similar rainfall zones.

SEASONAL FLUCTUATIONS

Rainstorms a mile or more wide often move across the range for a few miles, giving one particular area a rain of perhaps a half inch

or more. A short distance away from the storm path, the soil remains dry and the vegetation is left without water. More frequently, the rain on most of the favored strip is less than 0.25 inch, and evaporates so rapidly after the storm that plants receive only a very temporary benefit. By the time such localized showers have

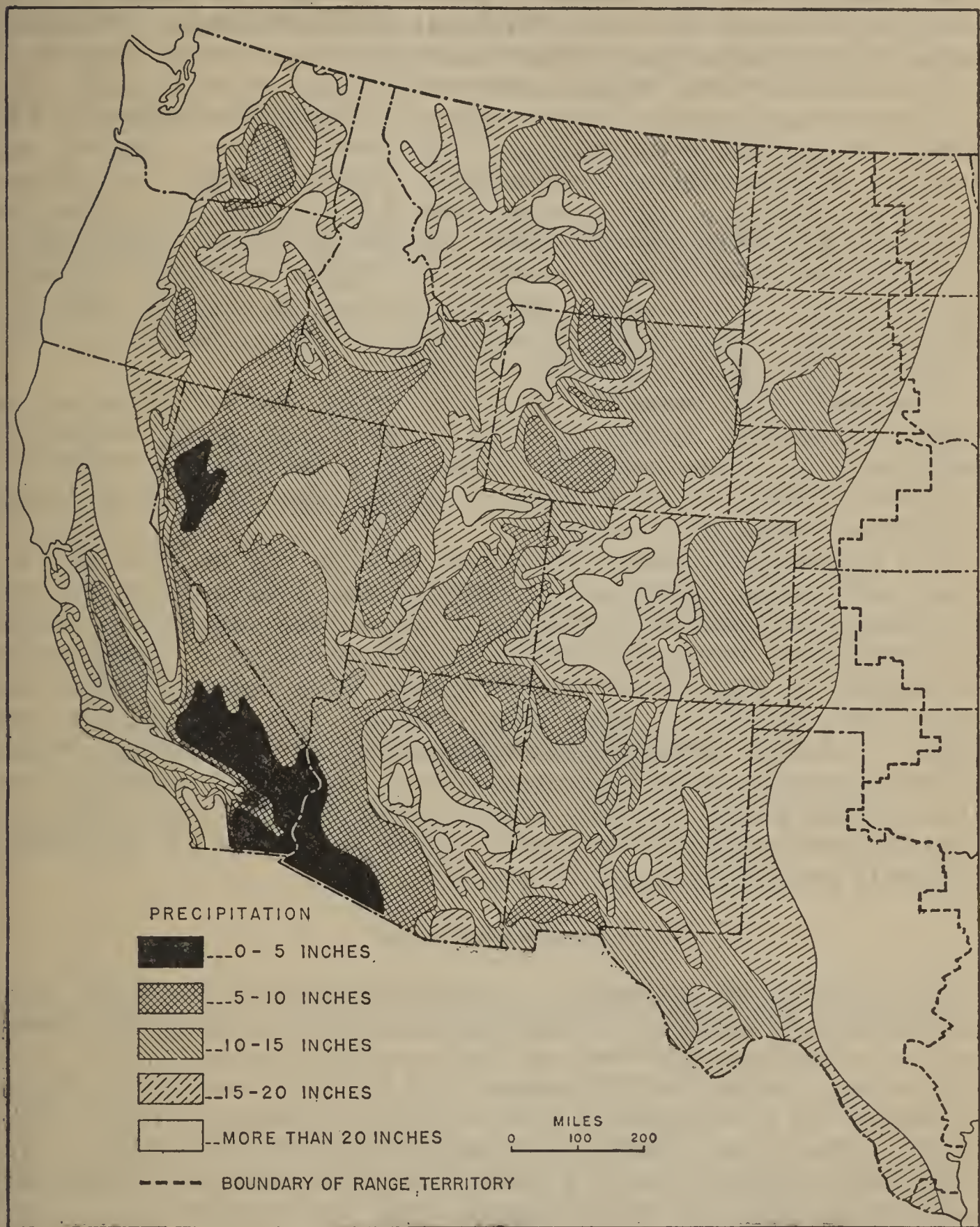


FIGURE 44.—There are several main precipitation zones within the western range territory. The desert and semidesert of the southwestern and intermountain regions are especially dry.

occurred intermittently during the summer, the range has received a greatly varying total rainfall of correspondingly uncertain benefit to the forage. On the Jornada Experimental Range, an area 20 miles square in southern New Mexico, where the average summer rainfall is 4.78 inches, Forest Service records show that actual rainfall during the summer of 1930 at different locations varied from 2.50

to 6.60 inches. Such differences, which occur even in favorable years, necessarily cause forage growth to be spotty. For example, the estimated forage crop in 1930 on the Jornada range was 100 percent where the rainfall was average or better but only 50 percent where rainfall was at the lowest point. Because the Jornada range was conservatively grazed, the stand of forage was maintained in that year even on the areas of lowest productivity; but on similar areas of low rainfall on overgrazed ranges, depletion as high as 15 percent was observed in that one year.

Seasons vary greatly between regions within the range area. The season of greatest precipitation in the Great Plains is spring and summer; but in most of California it is winter, with every season of the year bringing rain to some part of the range (81). The precipitation also varies in character. In the Southwest nearly all of the moisture comes as rain, while on the higher and more northerly ranges, much of it is snow. Average annual snowfall at Phoenix, Ariz., is only a trace, but at Boise, Idaho, it is 25 inches, and at Yellowstone Park, Wyo., 97 inches (156).

Temperature is important in determining the actual period of forage production, because growing plants require warm weather in addition to available moisture. Thus, the plant in Idaho under several feet of snow is just as dormant as the plant in Arizona during continued warm, dry weather.

The seasonal differences in climate between regions, and between years within each region cause corresponding differences in the start of plant growth and in the volume of range forage produced. Range use that allows livestock to graze the forage before it is sufficiently developed, or that otherwise disregards these seasonal differences contributes greatly to range deterioration. For example, the time when bluebunch wheatgrass, an important forage species, started growth in southeastern Idaho varied from March 20 to April 24 during a 9-year period. A loss of 49 percent of the forage value was caused in one experimental pasture where the vegetation was grazed too early every year for the 9 years.

DROUGHT YEARS

The severity of drought on western ranges can be more fully appreciated by comparison with the eastern farm belt. The lowest annual rainfall for the State of Ohio was 26.56 inches in 1934, while the average annual is 37.75 inches; but in Utah the lowest rainfall recorded was 8.38 inches in 1900, while the average is 12.87 inches (156). The worst drought ever recorded in the Corn Belt or the Cotton Belt appears to be an abundance of rainfall when contrasted with the average on western ranges (fig. 45). The lowest annual rainfall at any stations throughout the West and East make an even more striking contrast. For example, the lowest rainfall ever recorded at Des Moines, Iowa, was 18.24 inches in 1910, or 57 percent of average; but at Miles City, Mont., rainfall during the 1934 drought was only 5.51 inches, or 40 percent of average.

Drought is both severe and frequent on the western range. Using 75 percent of the average annual precipitation as an arbitrary criterion of drought for the range country, more than 3 years out of

every 10 are drought years over great areas, according to calculations which include only 1933 and thus exclude the severe 1934 drought (fig. 46). The Mohave-Gila Desert has drought 4 years out of 10, or nearly every other year, which alone labels it as the most unreliable country for grazing in the West. The semidesert ranges of the Southwest and Intermountain regions are only slightly less hazardous. Certain portions of the Great Plains have drought 3 years in 10, a hazardous situation even for range use, but much more risky for cultivated crops not as well adapted as the native vegetation to such vicissitudes.

THE MENACE IN A RECURRENCE OF DRY YEARS

The year 1934 was so severe that it focused the attention of the entire Nation upon the disastrous consequences of drought. But few

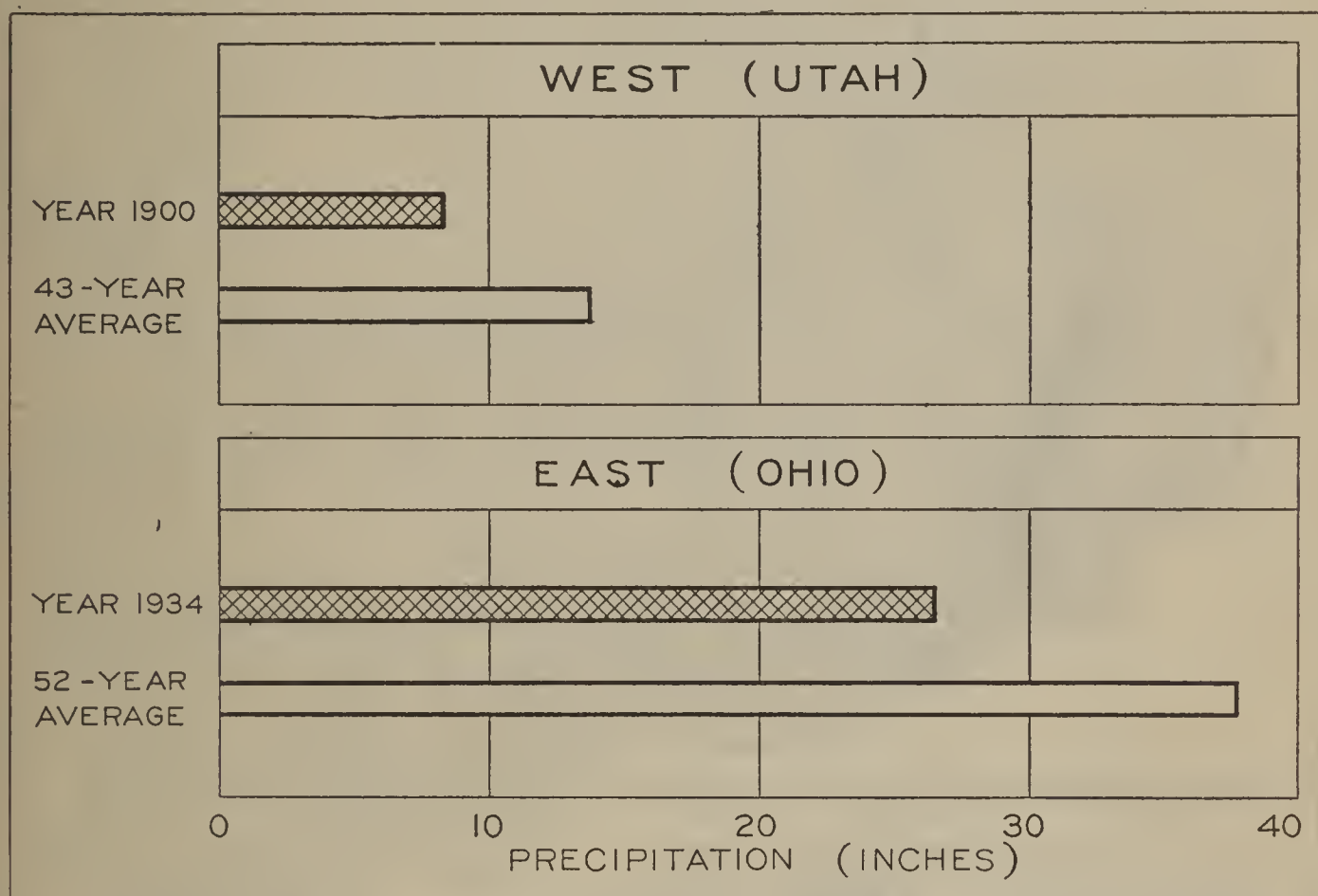


FIGURE 45.—The worst drought ever recorded in the East seems abundant moisture when compared with even the average rainfall in the West, as shown by two representative States.

people realize that for most of the afflicted range area, 1934 was in reality only the culmination of a series of years, mostly below normal (17). Rainfall records in the West show whole groups of years below average, with an occasional year of unusually low rainfall and other occasional years of high rainfall. For example, Miles City, Mont., had a long series of years with below-average rainfall from 1880 to 1905, and again from 1917 to 1934 (fig. 47).

There is hardly a year when it is not dry somewhere in the country, but the outstanding recent periods when dry years have occurred in one or more western regions include 1888 to 1890, 1892 to 1894, 1898 to 1904, 1910, 1917, 1919, 1924, and 1928 to 1934, inclusive. According to the statements of early settlers and actual records in recent years, most of these dry years contributed to the decline of the

range, and this decline was undoubtedly accentuated by overstocking which did not take into account sufficiently the effect of drought on the vegetation.

The periodic recurrence of wet and dry years suggested by available precipitation records is confirmed by the tree-ring studies of Douglass (43). Since trees ordinarily add a new ring of wood each

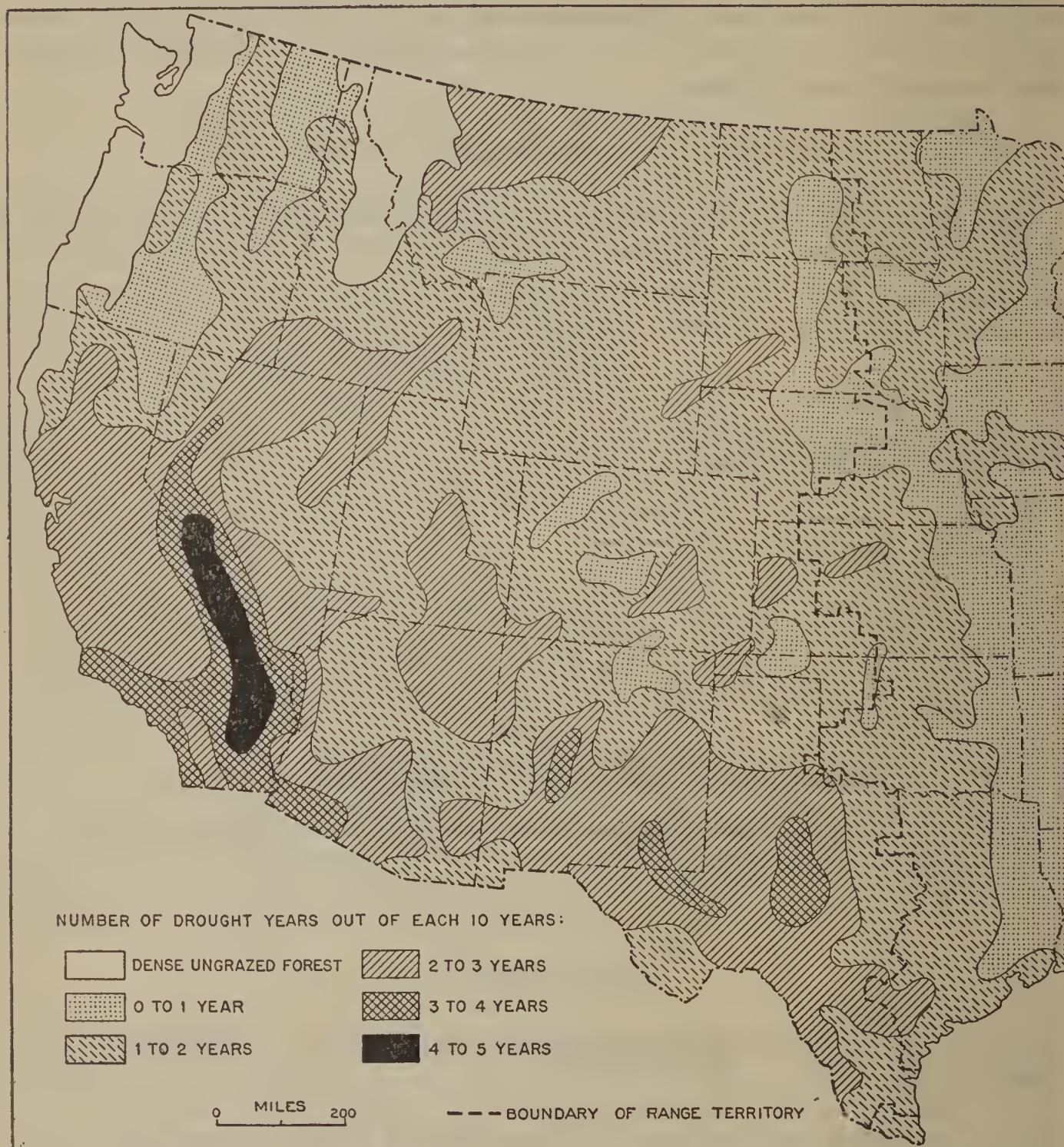


FIGURE 46.—DROUGHT FREQUENCY ON THE WESTERN RANGE.

The southwest and intermountain desert and semidesert ranges suffer drought (precipitation 75 percent of average or less) more frequently than other regions. (Based on 35-year averages 1899–1933, inclusive; calculations supervised by U. S. Weather Bureau.)

year, and the width of each ring corresponds to the precipitation available that year, with an accuracy of 70 to 85 percent, the tree-ring record gives good indication of the climate. In the case of the sequoias of California, the data extend as far back as 1310 B. C. and indicate cycles of 11 years. Dry years as shown by poor growth of ponderosa pines in the area of Flagstaff, Ariz., occurred in 14- and 21-year cycles, with major droughts about every 150 years, and minor droughts at 40- or 50-year intervals.

Periods of poor growth in ponderosa pine forests in the Pacific Northwest were found to vary from 3 to 14 years between 1630 and 1930 (89). With such considerable variance in the periods of dry years, it is not possible to predict the exact rainfall for any single year in the future, although some progress has been made in this line (4). The outstanding fact is that dry years and the accompanying reductions of forage production and grazing capacity occur with such frequency that good range management requires stocking the range on a basis sufficiently conservative to avoid severe drought losses or forced sales.

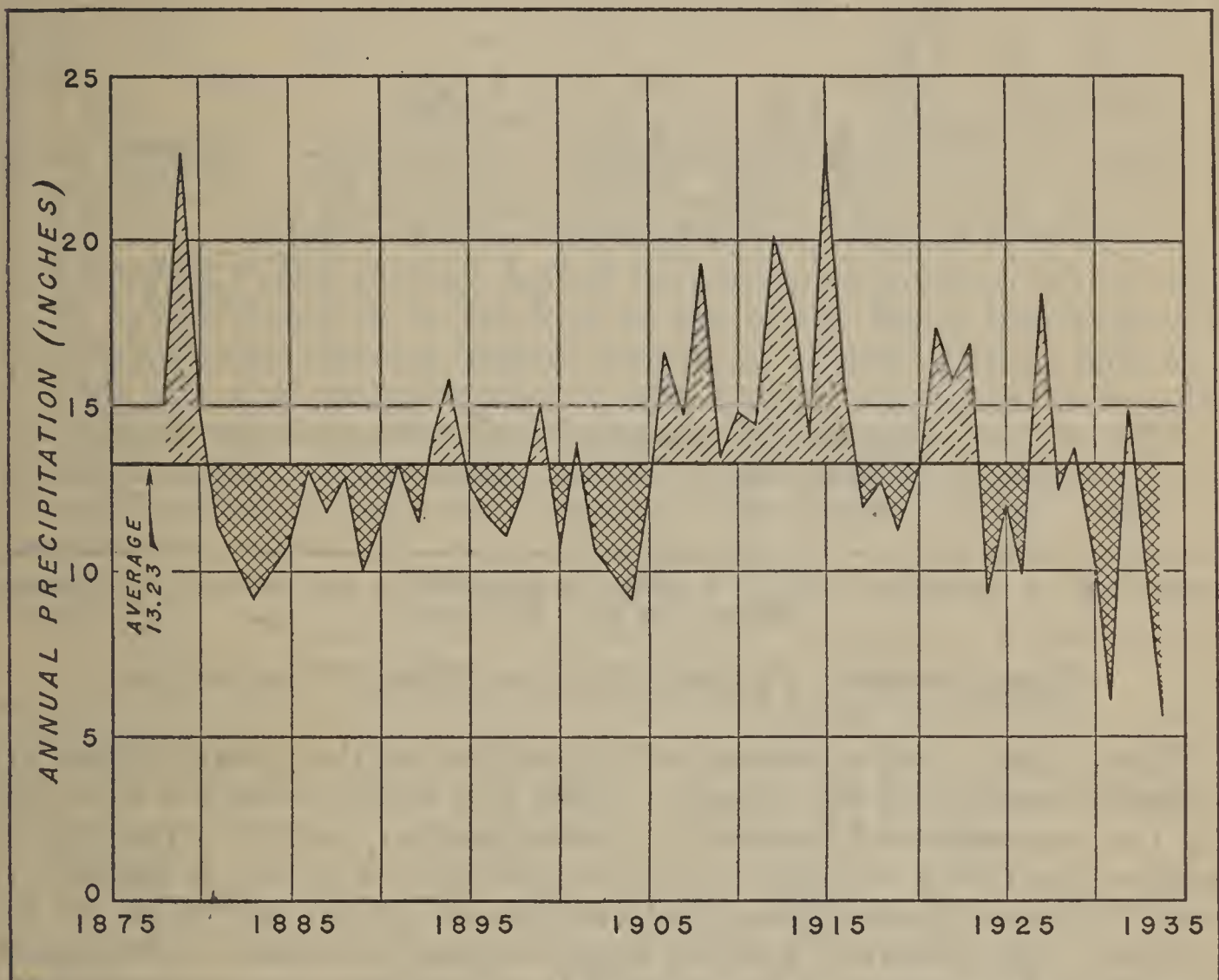


FIGURE 47.—Dry years may occur in groups, with greatly varying precipitation even during generally favorable periods, as shown by actual rainfall records at Miles City, Mont., a representative station for the range country.

PROGRESSIVE DEFICIENCIES

It is serious enough to have to plan for 3 or 4 years out of every 10 having less than average rainfall, but the longer weather cycles are particularly disheartening and require even more careful planning of range use. For example, Forest Service compilations show a decided downward trend in precipitation for the entire Intermountain Region since about 1908. In California there was a downward trend of 8 inches during the 80-year period from 1850 to 1930 (61), and further calculations show that the trend prevailed through 1934 (fig. 48). Such deficiencies may represent only the drier portions of long precipitation cycles, and it is possible that the trend may turn and continue upward for several decades. However, when progressive moisture deficiencies accumulate over the active span of 2 or 3

generations, even the peaks of short-term cycles need to be discounted in management plans that are to provide for avoiding excessive depletion. There is little question that this long-time deficiency in California has contributed to a depletion in that State of nearly 45 percent on private ranges and more than 50 percent on State and public-domain ranges.

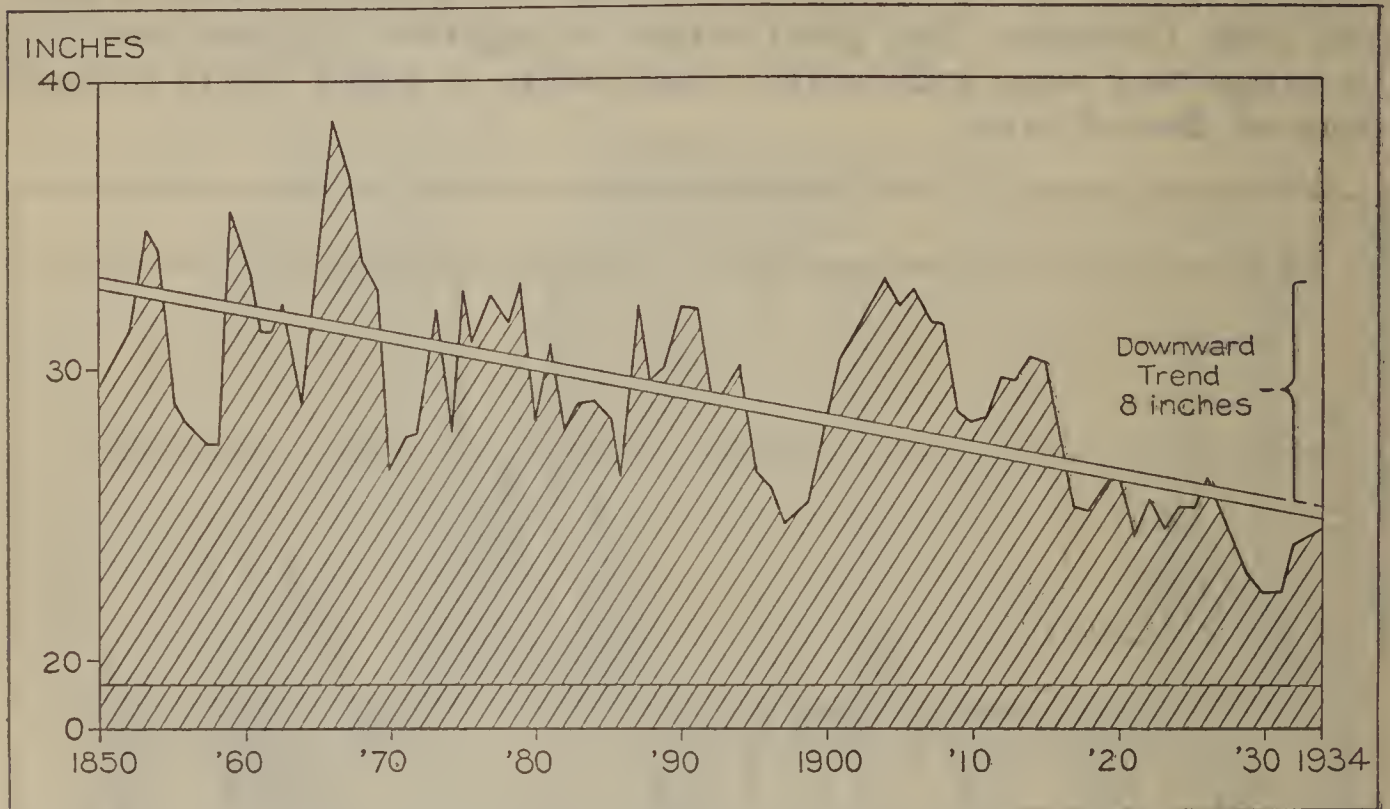


FIGURE 48.—A downward trend of 8 inches in precipitation has occurred in California during the past 85 years.

CORRESPONDING FLUCTUATIONS IN RANGE VEGETATION

The density and character of vegetation in the natural state are largely determined by climate. Even the casual observer is struck by the sparseness of western range vegetation, which is roughly in proportion to the rainfall zones in figure 44. A forest or pasture in the East, seen from directly above, covers all or nearly all of the ground. In the West, natural range vegetation covers on the average 20 to 50 percent of the ground, and less than 10 percent in the desert areas.

The adaptability of the individual plant to fluctuating climatic conditions, including the power of recuperation after severe loss of vigor during drought, is probably the most striking feature of western-range vegetation. Adjustments in the structure of plants which adapt them to dry climate, and which result in lower or more efficient water use, include reduced size, both of the whole plant and of the various parts, such as stems and leaves, thorns, hairs, resin, and wax on the stems and leaves, leaves that curl or fold, and leaves that drop off quickly, as in most cacti.

Many range plants make very effective use of the available water. Some of the native grasses require less than 400 pounds of water to produce one pound of dry plant material—in decided contrast with the requirements of many cultivated crops. The water requirement for alfalfa is over 800 pounds, and higher for some other plants (126). Moreover, Forest Service experiments in central

Arizona have indicated that transpiration from native shrubs and grasses during the summer is only 10 percent greater than evaporation from bare soil.

In spite of all these unusual characteristics of range plants, however, they have decided limits of endurance. There is a rather definite point in the drying of each kind of soil at which plants wilt, according to Briggs and Shantz (20). Most plants in the semidesert type wilt temporarily every afternoon during the summer.

Adequate soil moisture is determined very largely by the frequency of effective rainfall. Many light rains are not effective in promoting plant growth, any more than they contribute to the underground water supply. Light rains of 0.25 inch or less, which evaporate quickly, usually have only a very temporary benefit for the vegetation and contribute little lasting benefit to forage growth. Under usual summer conditions with dry soil, 0.5 inch or more may be required to start plant growth effectively. Then the growth may be greatly curtailed or stopped during the long periods between effective rainfall. The average period between precipitation of 0.5 inch or more was found to be 34 days at the Great Basin Experimental Range, a Forest Service branch station in central Utah. Effective rainfall is a vital consideration in sound range management because in reality overgrazing usually allows the forage to be used too closely between rains. Overgrazing on an experimental pasture at the Great Basin range caused a decline of 37 percent in the stand of grasses over a period of years, as compared to a conservatively grazed area.

The range vegetation is in a constantly fluctuating balance with the climate and other habitat factors such as soils and animals. The vegetation is naturally reduced extremely during drought but, given favorable rainfall, the range comes back after each decline—unless the natural decline during drought is so emphasized and intensified by overgrazing as to cause a fatal or permanent decline.

Altogether, the adaptability and recuperative powers of range plants have not been fully appreciated. Neither have range users as a group recognized the endurance limits of range vegetation, the variations in vigor of individual plants, and the extreme fluctuations in forage productive capacity over the range as a whole. This failure to recognize the fundamental nature of the resource has more than fully discounted the recuperative abilities of range forage under existing climatic conditions and has been a major factor in the range depletion outlined in other sections of this report.

RANGE FORAGE PRODUCTION DECLINES IN DRY YEARS

Forage production varies greatly from year to year. The volume of range forage produced is actually made up of growth made by plant parts which livestock relish and eat readily. By and large, the grasses, especially perennials, furnish the bulk of the feed, so that measurements of forage production are usually based mainly upon the growth made by the existing stand of grasses. But the stand itself fluctuates greatly. During the 1933-34 drought, 74.8 percent of the short grass plants were killed on overgrazed experimental pastures in western Kansas and 64.6 percent on moderately grazed areas (122).

Fluctuations in height growth of key range grasses effectively show the nature of the problem which must be faced each year in range use. For example, height growth of Smith's wheatgrass near Miles City, Mont., was 13 inches in 1933, 1 inch in 1934, and 15 inches in 1935, according to Forest Service measurements. Height growth of grasses has been shown to have a close relationship to rainfall in numerous other Forest Service experiments (93, 30, 115).

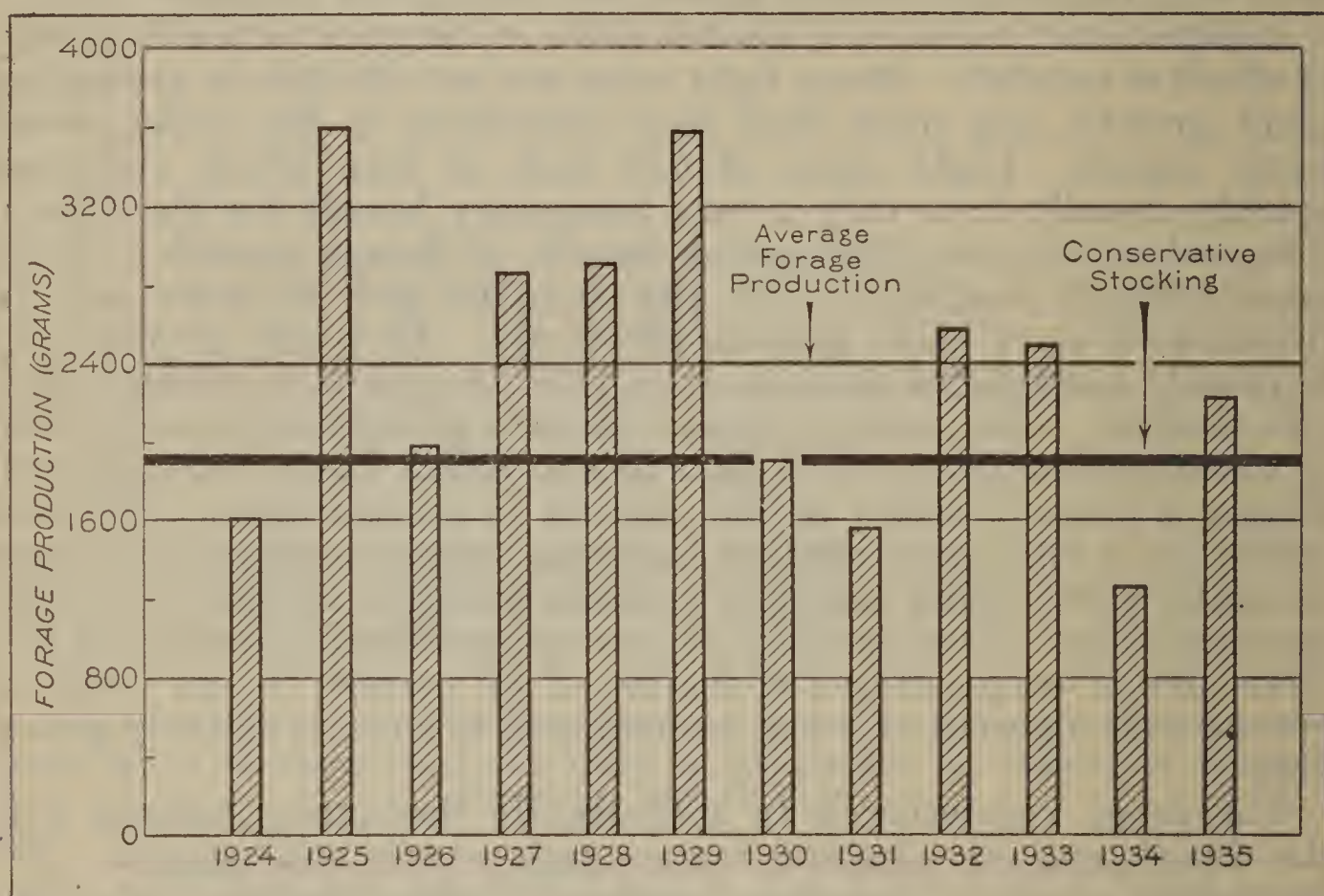


FIGURE 49.—Range forage production fluctuates so greatly from year to year that conservative stocking must be 20 percent or more below average production to furnish adequate forage in all but lowest years.

The variations in the height growth of grass are indeed considerable, but the variations in actual amounts of forage produced are even more startling. In Forest Service studies of important forage plants in several parts of the West, production of black grama in southern New Mexico varied from 98.9 grams per square meter in 1926 to 1.1 grams in 1928, with no production in 1934; Rothrock's grama in southern Arizona varied from 66.1 grams in 1927 to 6.9 grams in 1928; and mixed grasses in eastern Montana varied from 178.2 grams in 1927 to 24.9 grams in 1934. Mixed perennial grasses in central Utah varied from 3,598 grams per square rod in 1925 to 1,276 grams in 1934, with an average production of 2,379 grams over a 12-year period (fig. 49). It is obvious that stocking the range on the basis of average forage production would have provided adequate range feed in only 6 of the 12 years. Conservative stocking at approximately 20 percent below the average would have provided adequate forage in 9 years. This would have left considerable surplus feed in some years, which in itself is a form of insurance against inadequate range-feed production during drought.

The quantity of reserve range feed needed varies somewhat in different regions depending in part upon the relative frequency and severity of drought. Conservative stocking at a point 25 percent

below the average has been recommended by the Forest Service for the semidesert grass type (31).

On a national-forest range in central Utah, where conservative grazing has taken the forage fluctuations into account, the stand of forage has been improved 100 to 200 percent on spring ranges, and as much as 400 to 500 on depleted parts of the summer range, since the range was put under management (154, pp. 520-554). On the other hand, potentially better privately owned range areas in Ford and Parrish Canyons, subject to similar climate, but continually overgrazed for at least 10 years, were found to have lost 75 to 85 percent of the original total vegetation by 1930 (10).

EFFECT OF DRY SEASONS ON GRAZING USE

Climate largely determines the seasons of the year when range use is practicable. It is only natural that livestock owners should graze their animals on the range, where feed is cheap, as long as possible. However, snow and stormy weather usually prevent winter grazing on the high mountain ranges, although at lower elevations winter or yearlong grazing is often practiced. All in all, the critical seasons of the year on the range usually coincide with the occurrence of dry or otherwise unfavorable climatic conditions.

In the Southwest, the spring is ordinarily the most difficult season for range vegetation, as well as for range livestock. Temperatures rise sufficiently high to permit vegetative growth, but the necessary moisture is usually lacking. The soil and air are exceedingly dry, and winds often blow day after day. The dry soil loosened by grazing animals blows away from some plants exposing their roots and is deposited on others. On the Jornada range in southern New Mexico the black grama grass on several thousand acres of range was covered over and killed by deposits of several inches of sand blown from an adjacent severely overgrazed range in 1917 and 1918. During the drought, unmanaged range, heavily overgrazed, especially in the spring, declined 81 percent in comparison with a decline of 58 percent on the more conservatively grazed Jornada range (93).

The problem of adequate range forage during the spring and fall seasons is also serious in the intermountain region. Spring feed is especially important to give lambs and calves a proper start. A conservative grazing system introduced experimentally by the Forest Service at the United States Sheep Station in southeastern Idaho brought about a 15-percent improvement in spring-fall ranges in 9 years. Sheep were turned onto the range in the spring only after soil moisture and rising temperatures had allowed the bunch-grasses to become well started. In the same 9 years, forage production declined 50 percent on unmanaged range where too many sheep were placed on the range too early in the spring and were allowed to overgraze the vegetation.

VEGETATIVE STAND DECREASES AFTER DROUGHT

In 1935 the stockmen and others in many sections of the West were surprised by what appeared to be quick recovery of range vegetation from the severe 1934 drought. Once again, just as in

previous decades, came overconfident statements to the effect that only a few more drops of rain are all that the West needs to “bring the range back” (3). What actually happened was rather less reassuring than what was popularly assumed to have occurred. True, grasses made good height growth over most of the West where good rains fell. For example, the height growth of spiked wheatgrass in southern Idaho was 8 inches in 1935 as compared to 4.6 inches in 1934, and black grama in southern New Mexico was 16.1 inches in 1935, as against 2.2 inches in 1934. But the stand or density of vegetation was far from being brought back, especially on overgrazed ranges. Measurements in 1935 showed that the grass density even on plots protected from grazing declined 77 percent as a result of the 1934 drought in central Arizona. Measurements at several locations in the West showed that as a result of the 1934 drought, the density of grasses continued to decrease in 1935 even

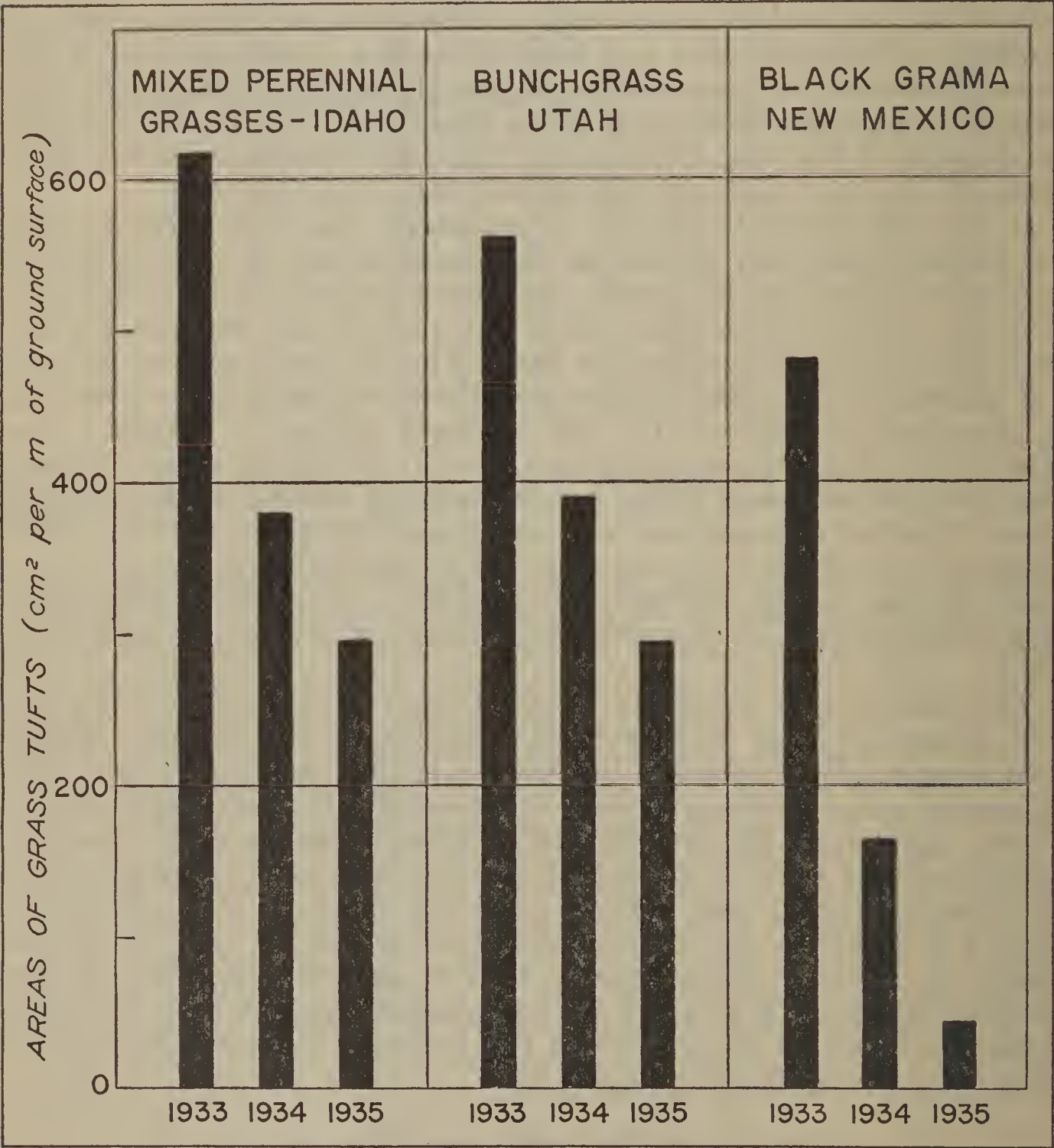


FIGURE 50.—EFFECT OF DROUGHT ON AREA OF GRASS TUFTS.

The density of vegetation continued to decline in 1935 in all of these three regions, as a result of the 1934 drought, even on ungrazed plots.

on ungrazed plots, although the 1935 rainfall was about normal (fig. 50). Those who saw "recovery" in 1935 failed to realize that livestock cannot thrive permanently on a single year's good height growth produced by a stand of vegetation thinned and weakened by drought and overgrazing. It requires both a good stand or density of vegetation and height growth to produce the volume of forage necessary for stabilized range use. Forest Service studies show that it takes 3 to 5 years of favorable precipitation to restore drought-depleted stands of sod-forming grasses and good-seeding bunchgrasses even under conservative grazing. Unfortunately, the types containing poor-seeding bunchgrasses are widespread in the West and have continued to deteriorate, as shown in previous sections.

The continued decreases in stands of range forage observed in 1935 confirm studies on the Jornada Range in southern New Mexico, which show that the stand of black grama increases or decreases in accordance with the rainfall for the previous year (93). Thus unusually low rainfall in 1921 caused a decrease of 89 percent in the stand on ungrazed plots during the 2 years 1922 and 1923. The loss was largely restored by 1926 under higher rainfall. Measurements during the same period on range overgrazed year after year showed that the black grama was completely killed out during the drought of 1922 and 1923, and was replaced by snakeweed and other worthless or poor forage plants during the following years of higher rainfall.

CYCLIC FLUCTUATIONS IN VEGETATIVE GROWTH

The foregoing examples indicate the nature of the cyclic trends in the stand of range vegetation. Just as the volume of wood grown each year by a tree (as indicated by the thickness of tree rings) reflects the annual and cyclic variations in precipitation, so the range vegetation fluctuates from year to year and over periods of dry and wet years.

Fluctuations in density of range vegetation, broadly corresponding to increased or decreased precipitation, have been observed in many parts of the West. For example, a stand of mixed perennial grasses in southern Idaho varied from 969 cm² per square meter in 1926 to 296 cm² in 1935. A similar stand in central Utah varied from 774 cm² in 1931 to 295 cm² in 1935. A bunchgrass type in northern Arizona varied from 856 cm² in 1912 to 2,686 cm² in 1930. The stand of vegetation may recuperate wonderfully in good years only to decrease again during drought. Overgrazing or other practices which fail to accord with good range management and violate the scheme of nature so impair the vegetation that instead of recuperating during years of favorable rainfall, it actually regains very little of its original stand and then declines further in the next drought. Forest Service studies on western Utah winter ranges show that the drought from 1931 to 1934 caused a 20-percent decrease in available forage plants on ungrazed plots, but on overgrazed areas within a few miles of water, depletion was approximately 60 percent (136).

Severe drought also affects the soil unfavorably. The stand of vegetation is so reduced that the unprotected soil is exposed to greatly

accelerated erosion by both wind and water. The now famous "dust bowl" of western Kansas and eastern Colorado is an extreme example of wind erosion during and following drought. The removal of the fertile upper soil layers exposes the raw subsoil and makes it just so much more difficult to restore the range vegetation. Accelerated water erosion, which is more fully discussed in another section, is fully as detrimental to range productivity as wind erosion.

That actual management of livestock on the range has utterly disregarded the probability of recurrent drought is shown by a comparison of livestock numbers with rainfall. In New Mexico, for example, the major peaks in livestock numbers correspond with the major drought periods. Although rainfall steadily decreased from 1931 to the low point in 1934, livestock numbers continued to increase during the entire period (fig. 51). On January 1, 1934, after one dry year and at the beginning of one of the worst drought years ever recorded in the State, livestock numbers were at the highest point in over a decade. The Government relief purchases in the summer of 1934 automatically reduced livestock numbers and absorbed some of the losses that private owners otherwise would have suffered.

The same sort of thing happened in New Mexico in nearly every drought period. Although rainfall dropped abruptly during 1916 and 1917, livestock numbers increased in those two years and dropped off rapidly in 1918 and 1919. Again, the rainfall decreased greatly during the period from 1920 to 1922, but livestock numbers increased during 1920 and 1921 to a peak on January 1, 1922, then dropped off sharply through wholesale starvation losses and distress sales during the culmination of the drought in 1922 and early 1923. Undoubtedly the ranges were badly depleted in 1917 and 1922 so that the peak of livestock numbers in 1934 was considerably below the preceding two high points. The records for other States and for the entire western range area show much the same thing.

Some vegetative types are much more susceptible to depletion during drought than others. A conservatively grazed black grama type in southern New Mexico declined 77 percent from 1933 to 1935, and a lightly grazed short-grass type in eastern Montana declined 67 percent, but a mixed perennial type in the Wasatch Mountains of central Utah declined only 48 percent during the same period. Forest Service records of these areas during previous droughts indicate similar relationships. Stands of vegetation which vary most offer least resistance to continued depletion as a result of overgrazing. This factor of susceptibility to depletion must be taken into account in any program of use adjustment.

CLIMATIC GUIDES TO PERMANENT RANGE USE

The delimitation of the range area and of definite regions in which range or agricultural use is particularly hazardous, is a necessary step in any forward-looking land-use program. Final fixing of the boundaries of marginal and submarginal areas will, of course, be dependent upon economic and other considerations, but climate alone can indicate broad regional characteristics of suitability for grazing and cultivation.

For example, the annual rainfall is below 5 inches over much of the Mohave-Gila Desert in southwestern Arizona and southeastern

California. The available soil moisture there is simply too scant to support sufficient palatable vegetation, and the supply of water for livestock is so scarce that little attempt has been made to graze large areas. Although the desert may furnish occasional winter grazing, it is not dependable.

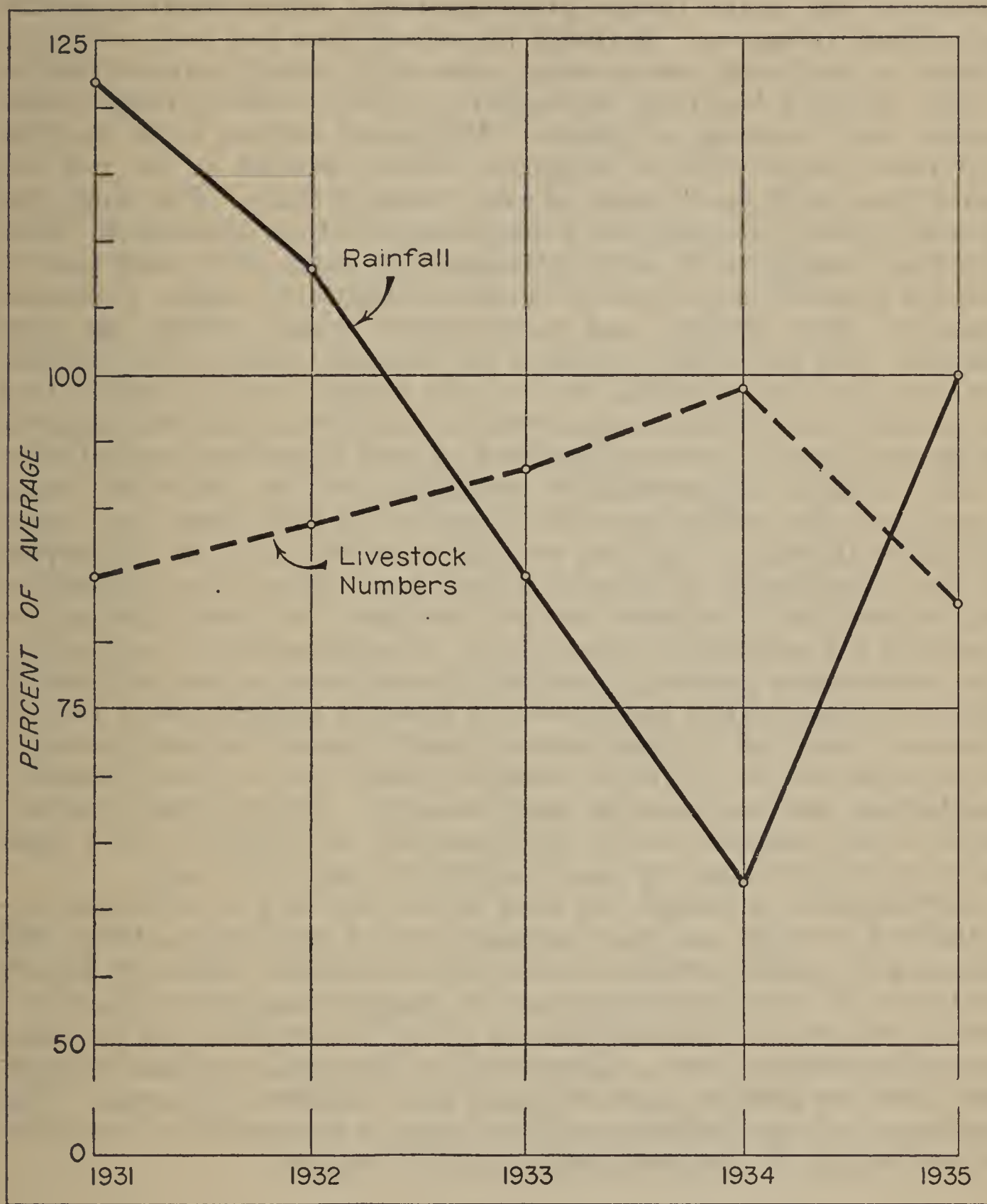


FIGURE 51.—STOCKING NOT ADJUSTED TO RAINFALL.

Livestock numbers increased in New Mexico during each of three such major drought periods as that of 1933-34, shown above. A typical example of the stocking of ranges without regard for natural fluctuations in range forage production. (Percentages are based on average annual precipitation and on animal units as of January 1 for the period 1915-35.)

Adjacent to the desert is the zone with 5 to 10 inches of rainfall extending from south-central Arizona as far north as Boise, Idaho. Nearly all of this great semidesert area is grazed at some time during the year, but drought is frequent and the range types are very susceptible to depletion, facts which explain why the area de-

teriorated so greatly during the major droughts of 1893, 1903, 1924, 1928 to 1931, and 1934. All of these factors combine to indicate that at least the drier part of the southern half of this great semi-desert zone may be marginal for permanent ranching. The northern half, where cooler temperatures encourage longer retention of soil moisture, has better forage production and offers better potential permanent range use. Actually the whole area has been badly depleted by continued overgrazing, especially during severe drought.

Dry farming has been attempted on many western range areas, where even ranching is difficult. Misguided settlers tried to grow cultivated crops without irrigation where rainfall is too low for other than range use in parts of every western State. The range was plowed under, cultivated for a few years, and then abandoned. Outstanding examples of such settlement in zones with less than a 15-inch rainfall have occurred in eastern Montana, eastern Colorado, southern New Mexico, and northwestern Utah, within the past decade. The net result has been the financial ruin of the hopeful farmers, and the physical ruin of the range area involved. Best permanent use of the range resource requires a national land-use program that will prevent repetition of such ill-advised exploitation.

The climatic characteristics prevailing on the principal range types, and their effect upon the depletion of such types, are major problems affecting range use, as will be evident later in this report in the classification of types for land use. Where the fluctuations and adversities of climate are not too great to permit range use, probably the outstanding prerequisite of management is the necessity for conservative grazing. Stocking the range at a point sufficiently below average forage production to provide adequate feed for the livestock in all but the most severe drought years is almost axiomatic in management to minimize drought losses, assure stable livestock production, and maintain the range resource. Beyond that, however, much more intensive study and analysis is required for a final solution of the climatic phases bearing on range land use.

Furthermore, although the land that is too dry or otherwise unsuitable for range use may be taken out of production, there still remains the major problem, in the face of climatic risks now known to occur, of developing systems of range management that will enable restoration and maintenance of the forage resources for those areas that remain in use. Years such as 1934 make a dismal picture, but there are always years of plenty that brighten the aspect. The problems are not insurmountable; they are susceptible of solution, as outlined in the program sections of this report.



